New Multi-Use Launch Pad Widens Access to Commercial Space Industry

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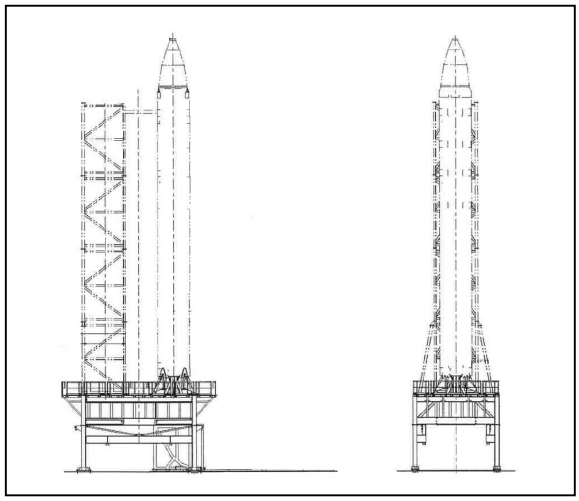
NASA is one step closer to its mission of transforming Kennedy Space Center into a 21st century multi-user spaceport. This summer marked the completion and unveiling of its new small class vehicle launch pad – known as Launch Pad 39C.

Launch Pad 39C is located approximately 3.5 miles northeast of the Vehicle Assembly Building (VAB) within the southeast portion of the existing Launch Pad 39B. The complex, which had formerly been used for Apollo and Space Shuttle missions, is being reconfigured for NASA's new space exploration vehicle – the Space Launch System (SLS) – and the site's new Launch Pad 39C will serve as a multi-purpose launch site for a variety of small class government and commercial launch vehicles.

A ribbon cutting and dedication ceremony was held at Kennedy Space Center in Florida on Friday, July 17, 2015, marking a significant milestone in NASA's mission to convert Kennedy to a 21st century multi-user spaceport.

The project was a cooperative effort between multiple Kennedy organizations, including Ground Systems Development and Operations, Center Planning and Development, Engineering, Construction of Facilities and Procurement. The project started when the Department of Defense approached NASA with a concept of developing a low-cost launch site for small class launch vehicles. With a limited construction budget (less than $1,000,000) and an aggressive schedule to complete a sitting study, design, environmental permitting and construction within a 21-month period, NASA, along with team members from Jones Edmunds & Associates Inc., a Florida-based consulting engineering firm, worked together to make this vision a reality.



The new launch pad was developed to accommodate mobile launch equipment for a small class launch vehicle with a maximum 90-foot height and a maximum of 200,000 pounds of thrust.

The Department of Defense's planned launch vehicle was intended to use liquid oxygen and liquid methane for fuel. NASA decided to develop the launch site so it was flexible and adaptable to a variety of government and commercial customers in line with the multi-user spaceport concept.

NASA conducted a siting study in October 2013 with help from Jones Edmunds. Stakeholder meetings were critical to define goals, develop requirements, and identify critical siting and design factors so that a final location for the new pad could be determined. Critical siting and design factors studied included transporter access, site layout, launch vehicle exhaust impacts, flight hazards, structural design, environmental protection, construction cost and schedule. Three potential launch sites were considered with the final recommendation being to locate the new pad within the southeast portion of the Pad 39B complex, in the location of a former oxidizer farm facility used for the former Space Shuttle Program. The majority of the former oxidizer farm had since been demolished, making the location a viable candidate for the new pad.

Launch Pad 39C was developed to be a "clean pad," meaning minimal permanent above-ground improvements other than concrete launch and equipment pads and vehicle circulation areas. Future users of the site could bring their own mobile launch structure, flame deflector, fueling systems and mobile launch control center to the site, then remove the equipment after launch. This makes the new pad versatile and able to accommodate a variety of small class launch systems. The concept for the Pad 39C site includes the possibility of on-site vehicle and launch tower assembly and processing, and off-site assembly and processing, followed by movement of the assembly to the launch site on a transporter or a transporter erector launcher with flame deflector.

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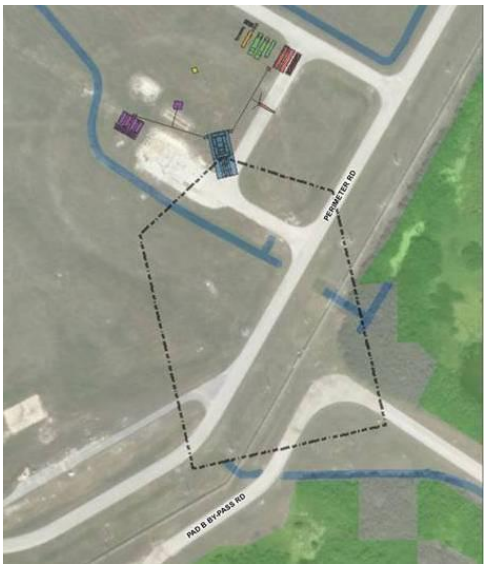
A special 100-ton transporter could be used to move flight hardware from off-site assembly and processing locations to the pad site. This required analysis of several potential routes to the pad site. The analysis included vertical and horizontal alignment geometry to ensure the limits of the transporter were not exceeded. The transporter has a 40-foot turn radius, a loaded travel speed of 1.25 miles per hour, an outside-to-outside wheel width of 18 feet 8 inches, an overall width of 20 feet, a loaded maximum grade limitation of 6 percent, and a loaded weight of 350,000 pounds. The anticipated transporter route to the Pad 39C site met the transporter's geometric criteria with only minor modifications within the Launch Pad 39B perimeter. A conceptual pavement analysis also was performed, the results of which indicated only minimal additional wear to existing roadway pavement would be encountered from fully loaded transporter passes.

A variety of launch structure and flame deflector orientations were analyzed based on the expected launch vehicle exhaust impact area calculated by NASA's engineers. The maximum exhaust impact area is expected to be approximately 500 feet longitudinally outward from the flame deflector and approximately 160 feet laterally from the flame deflector. A thermograph of the modeled exhaust plume provided by NASA was used to determine potential impacts to existing site features.



A wetlands area located east of the new launch pad site was in the direct line of the exhaust impact area. As a result, the orientation of the pad was revised so that the flame deflector would be on a southeast orientation, such that the launch vehicle exhaust would not impact the wetlands. This helped NASA minimize costs and protect the delicate ecosystem surrounding the pad site. This also helped with environmental resource permitting through the St. Johns River Water Management District.

The launch exhaust impact area was oriented to avoid sensitive wetlands.

A flight hazard assessment was conducted for each of the three launch site options studied. The assessment estimated a flight caution area and flight hazard area associated with each launch site. The flight hazard area is the area and airspace around the launch pad and flight azimuth where individual risk from a malfunction during the early phase of flight exceeds $1x10^{-5}$. The flight caution area is outside the flight hazard area where individual risk from a launch vehicle malfunction is lower at $1x10^{-6}$.

In early 2014, following the study, NASA and Jones Edmunds began working on the project's design, including civil, electrical and structural elements. Construction drawings and technical specifications were prepared based largely on the results of the study. Civil design included paving, grading and stormwater management systems. Electrical design covered site power supply to the launch pad, as well as site communications utilities. However, the most complex portion of the design was the launch pad structural design.

The pad foundation was designed to support a variety of structural load types including dead, live, wind, blast, acoustic and thermal. Jones Edmunds' structural engineering team performed a complex structural analysis during the design phase using structural design software to consider over 500 loading scenarios, launch vehicle and launch tower configurations, and flame deflector impingement angles. This allowed engineers to create an array of loads for the types of vehicles and ground support equipment NASA is expecting to be used at the launch pad. The foundation was designed to support column and flame deflector reactions from loads during a hurricane without the launch vehicle on the pad, operations with an empty launch vehicle, operations with the launch vehicle filled with propellant, launch, and engine testing. The result was a reinforced concrete launch pad approximately 50-foot-long, 40-foot-wide, and almost 50 inches thick. In addition, a reinforced concrete slab-on-grade was designed to support a moveable flame deflector and located adjacent to the main launch pad.

A geotechnical investigation was conducted for the design of this project and included borings up to 70 feet below grade. Due to wet clayey sand layers that would be difficult to compact, the launch pad area was over-excavated approximately 4 feet below the bottom of the foundation, and layers of clean engineered structural fill were placed and compacted prior to forming and pouring the main reinforced concrete foundation.

Design and permitting were completed in August 2014. Several procurement methods were evaluated from a cost and schedule standpoint. To meet a very tight schedule for completion of the project and agency small business contracting goals, the construction project was awarded as a negotiated 8(a) contract to Frazier Engineering of Melbourne, Florida, a prequalified 8(a) small-disadvantaged business construction contractor. Construction of the project began in January 2015 and was successfully completed in June 2015, meeting the project's construction schedule and budget.

The extraordinary effort and level of dedication from all members of the design and construction team demonstrate NASA's commitment to transition Kennedy into a multi-user spaceport. Through the foundational work that was laid with this project, new doors of opportunity are opened for government and commercial customers that were once out of reach.